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(54) GASKETED MEMBRANE ELECTRODE ASSEMBLY FOR ELECTROCHEMICAL FUEL CELLS.

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Descripti n

FIELD OF THE INVENTION

This invention relates to electrochemical fuel cells, and, in particular, to a gasketed membrane electrode assembly for solid polym r el ctrolyte fuel cells.

BACKGROUND OF THE INVENTION

Solid polymer electrolyte fuel cells (SPFCs) have been shown to be reliable for generating electricity by the oxidation of a conventional fuel such as hydrogen. The long demonstrated life and relative simplicity of design make SPFCs particularly suitable for space and transportation applications.

A single solid polymer electrolyte fuel cell comprises an ion exchange membrane separating an anode and a cathode, all of which is interposed between electrically conductive separator plates. A plurality of cells make up an SPFC stack.

The anode and cathode in a solid polymer electrolyte fuel cell are planar in configuration, and are normally formed of porous electrically conductive sheet material such as carbon fiber paper. A suitable catalytic material, such as finely divided platinum, is typically applied to the surfaces of the anode and cathode facing the membrane to render the portions containing the catalytic material electrochemically active.

Typically, flow field grooves are molded or machined on the surfaces of the electrically conductive separator plates facing the anode or the cathode to accommodate reactant fluid distribution and reaction product collection and elimination.

In conventional SPFCs, the solid polymer membrane serves at least three functions. First, the membrane separates the anode from the cathode. Hydrogen fuel is oxidized at the anode to form protons (hydrogen cations), which migrate across the membrane to the cathode. Oxygen is reduced at the cathode and reacts with the migrated hydrogen cations to form water. Second, the electrochemically active region of the membrane serves as a medium through which the hydrogen cations migrate to the cathode. Third, the portion of the membrane extending beyond the electrochemically active region into the space between the separator plates serves as a gasket to prevent reactant gases from escaping to the atmosphere from between the separator plates.

An advantage of solid polymer membranes is their immiscible nature, which facilitates the separation and removal of reaction products. Other advantages of solid polymer membranes include their relative insensitivity to differential pressure between the anode and the cathode, their chemical stability and their non-corrosiveness.

A disadvantage of solid polymer membranes is their high cost. This cost is even greater in SPFCs where the membrane itself is used as a gasket, because more membrane area is required. Where the membrane serves as a gasket, the membrane must extend substantially beyond the electrochemically active region of the membrane and into the space between the graphite separator plates. That portion extending beyond the active region adds to the overall cost of the SPFC, but is not utilized as a medium for cation migration.

Examples of SPFCs in which the solid polymer membrane serves as a gasket include those developed and described by United Technologies Corporation (UTC) for zero gravity applications, rigorous naval applications, and extraterrestrial surface applications. In such UTC fuel cells, a portion of the solid polymer membrane is interposed between the anode frame and the cathode frame and functions as a gasket, preventing reactant gases from escaping to the atmosphere.

There are several disadvantages to configurations employing the membrane itself as a gasket. As already noted, the cost of solid polymer membranes is high, and using a portion of the membrane as a gasket requires a larger membrane area, thus increasing the overall cost of the fuel cell. Use of the membrane as a gasket also exposes the membrane edge to the atmosphere, thereby allowing the evaporation of water, required for effective cation transport, from the membrane. In addition, the gasketing portion of the membrane is in contact with the separator plates at about 70°C - 80°C (158°F - 176°F), thus further promoting the dehydration of the membrane edge and possible degradation of the membrane's physical and chemical properties. For example, contaminants such as various metal ions can leach out from the separator plates and diffuse through the portion of the membrane acting as a gasket to the electrochemically active portion of the membrane, thus reducing the membrane's ability to act as an ion exchange m dium. Another disadvantag of SPFCs in which the membran serves as a gasket is that, wh re the membrane, in its protonated form, contacts th separator plat s, the acidic membran will corrode the separator plates.

Cells which incorporate a gasket in addition to the membrane ar described in FR-A-2410059 and US-A-3134697. FR-A-2410059 r lat s to an installation for th production of a gas, such as hydrogen gas, by the

electrolysis of a liquid electrolyte. It comprises a series of alt rnately arranged electrodes and ion permeable membran s. Gaskets are provid d at th periphery of the membranes and seal off the area b tween the electrodes. In this l ctrolytic c ll, the gaskets do not extend b yond th periphery of th electrodes. US-A-3134697 describes a fuel cell comprising a pair of lectrod s separated by a membrane. The electrodes and membrane are interposed between a pair of end plates. The assembly is connected together through the intermediary of gaskets located betwe n the nd plates so that spaces are formed between the electrodes and the end plates for the introduction of reagents into the spaces. In this cell, the gasket is not interposed between the electrodes and the membrane.

OBJECTS OF THE INVENTION

It is therefore an object of the invention to provide a membrane electrode assembly for solid polymer fuel cells which minimizes the amount of membrane material in the fuel cell by employing a less expensive and more effective gasketing material at the periphery of the membrane, rather than employing the membrane itself as a gasket.

It is a further object of the invention to provide a membrane electrode assembly in which exposure of the edges of the solid polymer membrane to the environment surrounding the fuel cell is avoided, thus preventing dehydration of the membrane.

Another object of the invention is to provide a membrane electrode assembly in which a thinner, more electrochemically efficient membrane can be employed, since the gasketing function is performed by the gasketing material and not by the membrane itself.

Still another object of the invention is to provide a membrane electrode assembly which minimizes or eliminates contact between the membrane and the separator plates, thus reducing any corrosive attack on the separator plates by the acidic membrane, and also reducing contamination of the membrane by contaminants originating in the separator plates.

Further and additional objects will appear from the description, accompanying drawings, and appended claims.

The foregoing and other objects are achieved by a gasketed membrane electrode assembly comprising an anode and a cathode, each planar in configuration and having an electrochemically active portion. An ion exchange membrane is interposed between the anode and the cathode. A first layer of gasketing material is interposed between the anode and the membrane. A second layer of gasketing material is interposed between the cathode and the membrane. Both layers of gasketing material extend from the periphery of the membrane in a direction away from the electrochemically active portion of the electrodes.

In the preferred embodiment, the periphery of the membrane extends beyond the periphery of the electrodes. The membrane is preferably a solid polymer ion exchange membrane, typically a porous, sulfonated material. The preferred gasketing material is a nonhydrophilic thermoplastic elastomer.

The gasketed membrane electrode assembly is preferably consolidated into a single unit by employing a cold bonding process or by the application of heat and pressure. In the preferred embodiment, the consolidated gasketed membrane electrode assembly is interposed between electrically conductive separator plates such that the gasketing material substantially occupies the space between the periphery of the separator plates, thereby forming a seal.

The electrically conductive separator plates, sometimes referred to as flow field plates, contain flow channels for the transport of fluids to and from the membrane electrode assembly. The separator plates are preferably formed of graphite, but can also be formed of other suitable electrically conductive materials.

In a second embodiment, the gasketed membrane electrode assembly comprises an anode, a cathode, and an ion exchange membrane interposed between the anode and the cathode. The entire anode-membrane-cathode assembly is interposed between layers of gasketing material. A first layer of gasketing material extends from the periphery of the anode on the side facing away from the membrane and in a direction away from the electrochemically active portion of the anode. A second layer of gasketing material extends from the periphery of the cathode on the side facing away from the membrane and in a direction away from the electrochemically active portion of the cathode.

In another embodiment, the gasketed membrane electrode assembly comprises an anode, a cathode, and an ion exchange membrane interposed between th anode and the cathode. A layer of gasketing material extends from the periph ry of the anode on the side facing away from the membrane and in a direction away from the electrochemically active portion of the anode. In this mbodiment, the periphery of th cathode preferably extends beyond the periphery of th ion exchange membrane, and the periphery of the ion exchang membrane preferably extends beyond the periph ry of the anode.

In yet another embodiment, the gasketed m mbrane electrod assembly compris s a cathode, an anode,

and an ion exchange membrane interposed between the anode and th cathode. A layer of gasketing material extends from the periphery of the cathode on the side facing away from the membrane and in a direction away from th electrochemically active portion of the cathode. In this embodiment, the periphery of the anode preferably extends beyond the periphery of the ion exchange membrane, and the periphery of the membrane extends beyond the periphery of the cathode.

In another embodiment not according to the invention, the gasketed membrane assembly can be employed in the humidification portion of a fuel cell. Such a gasketed humidification membrane assembly comprises a water permeable membrane interposed between layers of gasketing material. The layers of gasketing material extend from the periphery of the membrane in a direction away from the central region of the membrane. The entire gasketed humidification membrane assembly is preferably interposed between separator plates, such that the gasketing material occupies the space between the periphery of the separator plates, thereby forming a seal.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the invention reference is made to the drawings wherein:

FIG. 1 is an exploded sectional view of the gasketed membrane electrode assembly prior to consolidation into a unitary assembly.

FIG. 2 is a sectional view of the gasketed membrane electrode assembly of FIG. 1 after consolidation into a unitary assembly, and interposed between electrically conductive separator plates to form a fuel cell unit.

FIG. 3 is an exploded sectional view of a second embodiment of a gasketed membrane electrode assembly prior to consolidation into a unitary assembly.

FIG. 4 is a sectional view of the gasketed membrane electrode assembly of FIG. 3 after consolidation into a unitary assembly, and interposed between electrically conductive separator plates to form a fuel cell unit.

FIG. 5 is an exploded sectional view of a third embodiment of a gasketed membrane electrode assembly prior to consolidation into a unitary assembly.

FIG. 6 is a sectional view of the gasketed membrane electrode assembly of FIG. 5 after consolidation into a unitary assembly, and interposed between electrically conductive separator plates to form a fuel cell unit.

FIG. 7 is an exploded sectional view of a fourth embodiment of a gasketed membrane electrode assembly prior to consolidation into a unitary assembly.

FIG. 8 is a sectional view of the gasketed membrane electrode assembly of FIG. 7 after consolidation into a unitary assembly, and interposed between electrically conductive separator plates to form a fuel cell unit.

FIG. 9 is an exploded sectional view of a gasketed humidification membrane assembly prior to consolidation into a unitary assembly.

FIG. 10 is a sectional view of the gasketed humidification membrane assembly of FIG. 9 after consolidation into a unitary assembly, and interposed between separator plates.

FIG. 11 is an exploded sectional view of a second embodiment of a gasketed humidification membrane assembly prior to consolidation into a unitary assembly.

FIG. 12 is a sectional view of the gasketed humidification membrane assembly of FIG. 11 after consolidation into a unitary assembly, and interposed between separator plates.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring first to FIG. 1 of the drawings, a gasketed membrane electrode assembly 10 prior to consolidation into a single unitary assembly is shown. As FIG. 1 illustrates, the gasketing material layers 12, 14 are placed on either side of the ion exchange membrane 16. Carbon fiber paper based electrodes 18, 20 form the top and bottom portions of the five layer gasketed membrane electrode assembly. In FIG. 1, electrode 18 is the anode and electrode 20 is the cathode.

The portion 16a of the membrane 16 that is interposed between the layers of gasketing material 12, 14 is kept to a minimum, being only large enough to ensure a good seal between the membrane and the gasketing material. Likewise, the portions 18a, 20a of the electrodes 18, 20 that overlap the gasketing material need only be large enough to ensure a good seal between the electrodes and the gasketing material.

FIG. 2 shows the gasketed membrane electrode assembly 10 after consolidation into a single unit and interposed between electrically conductive separator plat s 22, 24. Consolidation is achieved either by the application of heat and pr ssur (where the gasketing material is a thermoplastic elastomer) or by employing a cold bonding proc ss. Cold bonding involves the employment of solvents or adhesives to join the layers together.

Upon consolidation, portions 12a, 14a of the gasketing material layers 12, 14 are compressed between

the membrane 16 and the electrodes 18, 20. Other portions 12b, 14b of the gasketing material abut the edge 16b of membrane 16 and the edges 18b, 20b of the electrodes 18, 20. The portions 12b, 14b of the gasketing material layers 12, 14 that abut the edges of the membrane and the electrodes form a seal which effectively prevents leakage of reactant gases and reaction products into the atmosphere from between the separator plates 22, 24.

By forming a seal around the edge 16b of the membrane 16, the gasketing material also prevents the membrane 16 from being exposed to the environment and thus dehydrating.

The gasketing material layers 12, 14 are interposed between the peripheral portions 22a, 24a of the electrically conductive separator plates 22, 24, substantially filling the space between the electrically conductive separator plates 22, 24 around the periphery of the membrane electrode assembly 10, thus functioning as a gasket between the electrically conductive separator plates 22, 24.

The gasketing material layers 12, 14 may be formed of an elastomeric material suitable for in situ molding. A nonhydrophilic thermoplastic elastomer is preferred. Such preferred gasketing materials include Shell's KRATON brand butadiene/styrene copolymer and Monsanto's SANTOPRENE brand ethylene/propylene copolymer.

The ion exchange membrane 16 in its protonated form is acidic. Using an inert gasketing material instead of the ion exchange membrane 16 to fill the space between the peripheral portions 22a, 24a of the electrically conductive separator plates 22, 24 eliminates contact between the ion exchange membrane 16 and the separator plates 22, 24. As a result, there is less or no corrosive attack on the separator plates by the acidic membrane. Also, the electrochemically active portion of the ion exchange membrane 16 is more protected from contamination originating at the peripheral portions 22a, 24a of the electrically conductive separator plates 22, 24.

FIG. 3 shows a second embodiment of a gasketed membrane electrode assembly, designated generally as 30. In FIG. 3, the ion exchange membrane 16 is interposed between the anode 18 and the cathode 20. A portion 16c of the membrane 16 extends beyond the edges 18b, 20b of the electrodes 18, 20. The three layer electrode-membrane-electrode assembly is interposed between layers of gasketing material 12, 14 such that portions 12c, 14c of the gasketing material layers 12, 14 overlap the respective portions 18c, 20c of the electrodes 18, 20 on the sides facing away from the membrane 16.

FIG. 4 shows the gasketed membrane electrode assembly 30 of FIG. 3 after it has been consolidated into a single unit and interposed between electrically conductive separator plates 22, 24. As in the embodiment illustrated in FIG. 2, the gasketing material layers 12, 14 form a seal against the edges 18b, 20b of the electrodes 18, 20 and the edge 16b of the membrane 16. The portions 12c, 14c of the gasketing material layers 12, 14 overlapping the electrodes 18, 20 are now compressed between the respective electrodes 18, 20 and the respective separator plates 22, 24. Also, the gasketing material layers 12, 14 substantially occupy the space between the electrically conductive separator plates 22, 24 around the periphery of the membrane electrode assembly 30, functioning as a gasket between the separator plates 22, 24.

FIG. 5 illustrates a third embodiment of a gasketed membrane electrode assembly, designated generally as 40, in which the ion exchange membrane 16 is interposed between the anode 18 and the cathode 20 and the three layer electrode-membrane-electrode assembly is arranged in a stepped arrangement. As shown in FIG. 5, the edge 16b of the membrane 16 extends beyond the edge 18b of the anode 18 and the edge 20b of the cathode 20 extends beyond the edge 16b of the membrane 16. A single layer of gasketing material 12 is positioned on top of the electrode-membrane-electrode assembly such that a portion 12c of the gasketing material 12 overlaps a portion 18c of the anode 18 on the side of the anode 18 facing away from the membrane 16.

FIG. 6 shows the gasketed membrane electrode assembly 40 of FIG. 5 after it has been consolidated into a single unit and interposed between electrically conductive separator plates 22, 24. The gasketing material layer 12 forms a seal against the edges 18b, 20b of the electrodes 18, 20 and the edge 16b of the membrane 16. The portion 12c of the gasketing material layer 12 overlapping the anode 18 is now compressed between the anode 18 and the separator plate 22. Also, as in the embodiments of FIGS. 2 and 4, the gasketing material layer 12 substantially occupies the space between the electrically conductive separator plates 22, 24 around the periphery of the membrane electrode assembly 40, thereby forming an effective seal between the separator plates 22, 24.

FIG. 7 illustrates a fourth embodiment of a gasketed membrane electrode assembly, designated generally as 50. In this embodiment, as in the third embodiment, the membrane 16 is interposed between the anode 18 and the cathode 20 and the three layer electrode-membrane-electrode assembly is arranged in a stepped arrangement. However, the anode 18 and the cathode 20 are reversed from their positions in the third embodiment. Thus, the edge 16b of the membrane 16 extends beyond the edge 20b of the cathode 20, and the edge 18b of the anode 18 extends beyond the edge 16b of the membrane 16. A single layer of gasketing material

12 is positioned on top of th electrode-membran -electrode assembly such that a portion 12c of the gasketing material lay r 12 overlaps a portion 20c of the cathode 20 on the side of the cathode 20 facing away from the membrane 16.

FIG. 8 shows the gasketed membrane electrode assembly 50 of FIG. 7 after it has been consolidated into a single unit and interposed between electrically conductive separator plates 22, 24. The gasketing material layer 12 forms a s al against the edg s 18b, 20b of the electrodes 18, 20 and the edge 16b of the membrane 16. The portion 12c of the gasketing material 12 overlapping the cathode 20 is now compressed between the cathode 20 and the separator plate 22.

The table below shows the potential cost savings of the present gasketed membrane electrode assembly over conventional membrane electrode assemblies in which the membrane itself serves as the gasket between the separator plates. In order to provide an electrochemically active area of 36 square inches, the present gasketed membrane electrode assembly (referred to as GMEA in the table) requires only 42 square inches of membrane, compared to 81 square inches for the conventional assembly. With the present gasketed membran electrode assembly, 86% of the membrane is utilized as a cation exchange site, compared to only 44% for the conventional assembly. At a cost of $1.64 per square inch of membrane, the present gasketed membrane lectrode assembly results in a cost savings of about $64 per cell, or about $2,251 per 35 cell stack, representing a 48% savings on the membrane cost for a 35 cell stack.

GASKETED MEMBRANE ELECTRODE ASSEMBLY (GMEA)

Membrane Cost Savings

MEA Type	Membrane Area (in^2)	% Utilization[1]	Cost[2] ($)	Cost[3] ($)	% Savings[4]
Conventional	81	44	133	4,666	---
GMEA	42	86	69	2,415	48
Active Area	36	100	59	2,074	

[1] Percent of membrane utilized as an ion exchange site (active area), calculated as (Active area/Membrane area)x100.

[2] Cost of membrane for a single cell, calculated as Membrane Area (in^2) x $1.64 per in^2.

[3] Cost of 35 cell stack.

[4] Percent savings resulting from using a GMEA over a conventional assembly for a 35 cell stack, calculated as ((Cost of conventional assembly - cost of GMEA)/cost of a conventional assembly)x100.

Thus, a gasketed membrane electrode assembly is provided that reduces the cost of solid polymer fuel cells by reducing the amount of membrane material needed in the cell.

FIG. 9 illustrates a gasketed membrane assembly 60 for use in the humidification portion of a fuel cell, prior to consolidation into a unitary assembly. The gasketed humidification membrane assembly 60 is comprised of a water permeable membrane 26 interposed between layers of gasketing material 12, 14 such that portions 12c, 14c of the gasketing material layers 12, 14 overlap the periphery 26a of the membrane 26. Th layers of gasketing material 12, 14 extend from the periphery 26a of the water permeable membrane 26 in a direction away from the central region of the membrane 26.

FIG. 10 shows the gasket d humidification membrane assembly 60 of FIG. 9 after it has been consolidated into a single unit and interp sed between separator plates 22, 24. Upon consolidation, the portion 12c of the gasketing material lay r 12 overlapping the membrane is now compressed betwe n the membrane 26 and the separator plat 22, and th portion 14c of gasketing material layer 14 overlapping th membrane 26 is now

compressed between the membrane 26 and the separator plate 24. Other portions 12d, 14d of the gasketing material layers 12, 14 abut the edge 26b of the water perm able membran 26, forming a seal which eff ctively prevents l akage of gases into the atmosphere from between the separator plates 22, 24.

FIG. 11 illustrates another embodiment of a gasketed humidification membrane assembly, designated generally as 70, prior to consolidation into a unitary assembly. The gasketed membrane assembly 70 is comprised of a water permeabl membran 26 and a layer of gasketing material 12 extending from the periphery 26a of the membran 26 in a direction away from the central region of the membrane 26. A portion 12c of the gasketing layer 12 overlaps the periphery 26a of the membrane 26.

FIG. 12 shows the gasketed humidification membrane assembly 70 of FIG. 11 after consolidation into a single unit and interposed between separator plates 22, 24. Upon consolidation, the portion 12c of the gasketing material layer 12 overlapping the water permeable membrane 26 is now compressed between the membrane 26 and the separator plate 22. A portion 12d of the gasketing material layer 12 abuts the edge 26b of the water permeable membrane 26, providing a seal which prevents gases from escaping into the atmosphere from between the separator plates 22, 24.

Of course, many modifications and other embodiments of the invention will be recognized by one skilled in the art in view of the foregoing teachings.

Claims

1. A gasketed membrane electrode assembly for use in the electrochemically active portion of a fuel cell comprising:
   a. an anode having an electrochemically active portion;
   b. a cathode having an electrochemically active portion;
   c. an ion exchange membrane interposed between said anode and said cathode;
   d. a first layer of gasketing material interposed between said anode and said membrane, said first layer extending from the periphery of said membrane and from the periphery of said anode in a direction away from the electrochemically active portion of said anode; and
   e. a second layer of gasketing material interposed between said cathode and said membrane, said second layer extending from the periphery of said membrane and from the periphery of said cathode in a direction away from the electrochemically active portion of said cathode.

2. The gasketed membrane electrode assembly of claim 1 wherein the periphery of said membrane extends beyond the periphery of said anode and said cathode.

3. The gasketed membrane electrode assembly of claim 1 wherein said gasketing material is formed fr m a nonhydrophilic thermoplastic elastomer.

4. The gasketed membrane electrode assembly of claim 1 wherein said assembly is interposed between a pair of electrically conductive separator plates.

5. A gasketed membrane electrode assembly for use in the electrochemically active portion of a fuel cell comprising:
   a. an anode having an electrochemically active portion;
   b. a cathode having an electrochemically active portion;
   c. an ion exchange membrane interposed between said anode and said cathode;
   d. a first layer of gasketing material extending from the periphery of said anode on the side facing away from said membrane and in a direction away from the electrochemically active portion of said anode; and
   e. a second layer of gasketing material extending from the periphery of said cathode on the side facing away from said membrane and in a direction away from the electrochemically active portion of said cathode,

   said first and second layers of gasketing material forming a seal against the peripheral dges of said anod and said cathod , respectively, and the periph ral edge of said membrane.

6. Th gasketed membrane electrod assembly of claim 5 wherein the periphery of said membrane extends beyond the periphery of said anod and said cathode.

7. The gasketed membrane electrode assembly of claim 5 wher in said gask ting material is formed from a nonhydrophilic thermoplastic elastomer.

8. The gasketed membran electrode ass mbly of claim 5 wh rein said assembly is interposed b tween a pair of electrically conductive separator plates.

9. A gasketed membrane electrode assembly for use in the electrochemically active portion of a fuel cell comprising:
   a. an anode having an electrochemically active portion;
   b. a cathode having an electrochemically active portion;
   c. an ion exchange membrane interposed between said anode and said cathode; and
   d. a layer of gasketing material extending from the periphery of said anode on the side facing away from said membrane and in a direction away from the electrochemically active portion of said anode, said layer of gasketing material forming a seal against the peripheral edges of said anode and said cathode and the peripheral edge of said membrane.

10. The gasketed membrane electrode assembly of claim 9 wherein the periphery of said cathode extends beyond the periphery of said ion exchange membrane, and the periphery of said ion exchange membrane extends beyond the periphery of said anode.

11. The gasketed membrane electrode assembly of claim 9 wherein said gasketing material is formed from a nonhydrophilic thermoplastic elastomer.

12. The gasketed membrane electrode assembly of claim 9 wherein said assembly is interposed betwe n a pair of electrically conductive separator plates.

13. A gasketed membrane electrode assembly for use in the electrochemically active portion of a fuel cell comprising:
   a. an anode having an electrochemically active portion;
   b. a cathode having an electrochemically active portion;
   c. an ion exchange membrane interposed between said anode and said cathode; and
   d. a layer of gasketing material extending from the periphery of said cathode on the side facing away from said membrane and in a direction away from the electrochemically active portion of said cathode, said layer of gasketing material forming a seal against the peripheral edges of said anode and said cathode and the peripheral edge of said membrane.

14. The gasketed membrane electrode assembly of claim 13 wherein the periphery of said anode extends beyond the periphery of said ion exchange membrane, and the periphery of said ion exchange membrane extends beyond the periphery of said cathode.

15. The gasketed membrane electrode assembly of claim 13 wherein said gasketing material is formed from a nonhydrophilic thermoplastic elastomer.

16. The gasketed membrane electrode assembly of claim 13 wherein said assembly is interposed between a pair of electrically conductive separator plates.

Patentansprüche

1. Mit Dichtung versehene Membranelektrodenanordnung zur Verwendung im elektrochemisch aktiven Abschnitt einer Brennstoffzelle, umfassend:
   a. eine Anode mit einem elektrochemisch aktiven Abschnitt;
   b. eine Kathode mit einem elektrochemisch aktiven Abschnitt;
   c. eine zwisch n d r Anode und der Kathode ang ordnete Ionenaustauschmembran;
   d. ine rste Schicht Dichtungsmaterial, die zwischen der Anode und der Membran angeordnet ist, wobei sich diese erste Schicht von der Peripherie d r Membran und von der Peripherie der Anod in Richtung weg vom elektrochemisch aktiven Abschnitt der Anod erstreckt; und
   e. eine zweite Schicht Dichtungsmaterial, die zwischen der Kathode und der Membran angeordnet ist,

wobei sich diese zweite Schicht von der Peripherie der Membran und von der Peripherie der Kathode in Richtung weg vom elektrochemisch aktiven Abschnitt der Kathod erstr ckt.

2. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 1, worin sich di Periph rie der Membran über di Peripherie der Anode und der Kathode hinaus erstreckt.

3. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 1, worin das Dichtungsmaterial aus einem nicht-hydrophilen thermoplastischen Elastomer gebildet ist.

4. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 1, wobei sich die Anordnung zwischen einem Paar elektrisch leitender Separatorplatten befindet.

5. Mit Dichtung versehene Membranelektrodenanordnung zur Verwendung im elektrochemisch aktiven Abschnitt einer Brennstoffzelle, umfassend:
   a. eine Anode mit einem elektrochemisch aktiven Abschnitt;
   b. eine Kathode mit einem elektrochemisch aktiven Abschnitt;
   c. eine zwischen der Anode und der Kathode angeordnete Ionenaustauschmembran;
   d. eine erste Schicht Dichtungsmaterial, die sich von der Peripherie der Anode auf der von der Membran abgewandten Seite und in Richtung weg vom elektrochemisch aktiven Abschnitt der Anode erstreckt; und
   e. eine zweite Schicht Dichtungsmaterial, die sich von der Peripherie der Kathode auf der von der Membran abgewandten Seite in Richtung weg vom elektrochemisch aktiven Abschnitt der Kathode erstreckt,
   wobei die erste und die zweite Schicht Dichtungsmaterial eine Abdichtung gegen die periphere Kante der Anode bzw. der Kathode und die periphere Kante der Membran bilden.

6. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 5, worin sich die Peripherie der Membran über die Peripherie der Anode und der Kathode hinaus erstreckt.

7. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 5, worin das Dichtungsmaterial aus einem nicht-hydrophilen thermoplastischen Elastomer gebildet ist.

8. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 5, wobei sich die Anordnung zwischen einem Paar elektrisch leitender Separatorplatten befindet.

9. Mit Dichtung versehene Membranelektrodenanordnung zur Verwendung im elektrochemisch aktiven Abschnitt einer Brennstoffzelle, umfassend:
   a. eine Anode mit einem elektrochemisch aktiven Abschnitt;
   b. eine Kathode mit einem elektrochemisch aktiven Abschnitt;
   c. eine zwischen der Anode und der Kathode angeordnete Ionenaustauschmembran;
   d. eine Schicht Dichtungsmaterial, die sich von der Peripherie der Anode auf der von der Membran abgewandten Seite und in Richtung weg vom elektrochemisch aktiven Abschnitt der Anode erstreckt,
   wobei die Schicht Dichtungsmaterial eine Abdichtung gegen die peripheren Kanten der Anode und der Kathode und die periphere Kante der Membran bildet.

10. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 9, worin sich die Peripherie der Kathode über die Peripherie der Ionenaustauschmembran und die Peripherie der Ionenaustauschmembran über die Peripherie der Anode hinaus erstreckt.

11. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 9, worin das Dichtungsmaterial aus einem nicht-hydrophilen thermoplastischen Elastomer gebildet ist.

12. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 9, wob i sich die Anordnung zwischen einem Paar elektrisch leitend r Separatorplatten befindet.

13. Mit Dichtung versehene Membranelektrodenanordnung zur Verwendung im elektrochemisch aktiv n Abschnitt einer Brennstoffzelle, umfassend:
   a. eine Anode mit einem el ktrochemisch aktiven Abschnitt;

b. eine Kathode mit einem elektrochemisch aktiven Abschnitt;
c. eine zwisch n der Anode und d r Kathode angeordnete Ion naustauschmembran;
d. eine Schicht Dichtungsmaterial, die sich von der Peripherie der Kathode auf der von der Membran abgewandten Seite und in Richtung weg vom elektrochemisch aktiven Abschnitt der Kathode erstreckt, wobei die Schicht Dichtungsmaterial eine Abdichtung gegen die peripheren Kanten der Anode und der Kathode und die periphere Kante der Membran bildet.

14. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 13, worin sich die Peripherie der Anode über die Peripherie der Ionenaustauschmembran und die Peripherie der Ionenaustauschmembran über die Peripherie der Kathode hinaus erstreckt.

15. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 13, worin das Dichtungsmaterial aus einem nicht-hydrophilen thermoplastischen Elastomer gebildet ist.

16. Mit Dichtung versehene Membranelektrodenanordnung nach Anspruch 13, wobei sich die Anordnung zwischen einem Paar elektrisch leitender Separatorplatten befindet.

Revendications

1. Ensemble d'électrodes à membrane et garniture d'étanchéité, destiné à être employé dans la partie électrochimiquement active d'une pile à combustible, comprenant:
a. une anode comportant une partie électrochimiquement active;
b. une cathode comportant une partie électrochimiquement active;
c. une membrane échangeuse d'ions interposée entre l'anode et la cathode;
d. une première couche d'un matériau d'étanchéité interposée entre l'anode et la membrane, cette pr mière couche s'étendant à partir de la périphérie de la membrane et à partir de la périphérie de l'anode en direction opposée à la partie électrochimiquement active de l'anode; et
e. une deuxième couche d'un matériau d'étanchéité interposée entre la cathode et la membrane, cette deuxième couche s'étendant à partir de la périphérie de la membrane et à partir de la périphérie de la cathode en direction opposée à la partie électrochimiquement active de la cathode.

2. Ensemble d'électrodes à membrane et garniture d'étanchéité selon la revendication 1, dans lequel la périphérie de la membrane s'étend au-delà de la périphérie de l'anode et de la cathode.

3. Ensemble d'électrodes à membrane et garniture d'étanchéité selon la revendication 1, dans lequel le matériau d'étanchéité est formé à partir d'un élastomère thermoplastique non-hydrophile.

4. Ensemble d'électrodes à membrane et garniture d'étanchéité selon la revendication 1, dans lequel l' nsemble est interposé entre une paire de plaques séparatrices électroconductrices.

5. Ensemble d'électrodes à membrane et garniture d'étanchéité, destiné à être employé dans la partie él ctrochimiquement active d'une pile à combustible, comprenant:
a. une anode comportant une partie électrochimiquement active;
b. une cathode comportant une partie électrochimiquement active;
c. une membrane échangeuse d'ions interposée entre l'anode et la cathode;
d. une première couche d'un matériau d'étanchéité s'étendant à partir de la périphérie de l'anode sur le côté opposé à la membrane, et en direction opposée à la partie électrochimiquement active de l'anode; et
e. une deuxième couche d'un matériau d'étanchéité s'étendant à partir de la périphérie de la cathode sur le côté opposé à la membrane, et en direction opposée à la partie électrochimiquement active d la cathode,

les première et deuxième couches de matériau d'étanchéité formant un joint respectivement contr les bords périphériqu s de l'anode et de la cathode, et le bord périphériqu d la membran .

6. Ens mble d'él ctrod s à membrane et garniture d'étanchéité selon la revendication 5, dans lequel la périphérie de la m mbrane s'étend au-delà de la périphérie de l'anode t de la cathod .

7. Ensembl d'électrodes à membran t garniture d'étanchéité selon la rev ndication 5, dans lequel le matériau d'étanchéité est formé à partir d'un élastomère thermoplastique non-hydrophil .

8. Ensemble d'électrodes à membrane et garniture d'étanchéité selon la revendication 5, dans lequel l'ensemble est interposé entre une paire de plaques séparatrices électroconductrices.

9. Ensemble d'électrodes à membrane et garniture d'étanchéité, destiné à être employé dans la partie él ctrochimiquement active d'une pile à combustible, comprenant:
   a. une anode comportant une partie électrochimiquement active;
   b. une cathode comportant une partie électrochimiquement active;
   c. une membrane échangeuse d'ions interposée entre l'anode et la cathode;
   d. une couche d'un matériau d'étanchéité s'étendant à partir de la périphérie de l'anode sur le côté opposé à la membrane, et en direction opposée à la partie électrochimiquement active de l'anode,
   la couche de matériau d'étanchéité formant un joint contre les bords périphériques de l'anode et de la cathode, et le bord périphérique de la membrane.

10. Ensemble d'électrodes à membrane et garniture d'étanchéité selon la revendication 9, dans lequel la périphérie de la cathode s'étend au-delà de la périphérie de la membrane échangeuse d'ions, et la périphéri de la membrane échangeuse d'ions s'étend au-delà de la périphérie de l'anode.

11. Ensemble d'électrodes à membrane et garniture d'étanchéité selon la revendication 9, dans lequel le matériau d'étanchéité est formé à partir d'un élastomère thermoplastique non-hydrophile.

12. Ensemble d'électrodes à membrane et garniture d'étanchéité selon la revendication 9, dans lequel l'ensemble est interposé entre une paire de plaques séparatrices électroconductrices.

13. Ensemble d'électrodes à membrane et garniture d'étanchéité, destiné à être employé dans la partie électrochimiquement active d'une pile à combustible, comprenant:
   a. une anode comportant une partie électrochimiquement active;
   b. une cathode comportant une partie électrochimiquement active;
   c. une membrane échangeuse d'ions interposée entre l'anode et la cathode;
   d. une couche d'un matériau d'étanchéité s'étendant à partir de la périphérie de la cathode sur le côté opposé à la membrane, et en direction opposée à la partie électrochimiquement active de la cathod ,
   la couche de matériau d'étanchéité formant un joint contre les bords périphériques de l'anod et de la cathode, et le bord périphérique de la membrane.

14. Ensemble d'électrodes à membrane et garniture d'étanchéité selon la revendication 13, dans lequel la périphérie de l'anode s'étend au-delà de la périphérie de la membrane échangeuse d'ions, et la périphérie de la membrane échangeuse d'ions s'étend au-delà de la périphérie de la cathode.

15. Ensemble d'électrodes à membrane et garniture d'étanchéité selon la revendication 13, dans lequel le matériau d'étanchéité est formé à partir d'un élastomère thermoplastique non-hydrophile.

16. Ensemble d'électrodes à membrane et garniture d'étanchéité selon la revendication 13, dans lequel l'ensemble est interposé entre une paire de plaques séparatrices électroconductrices.

Fig. 1

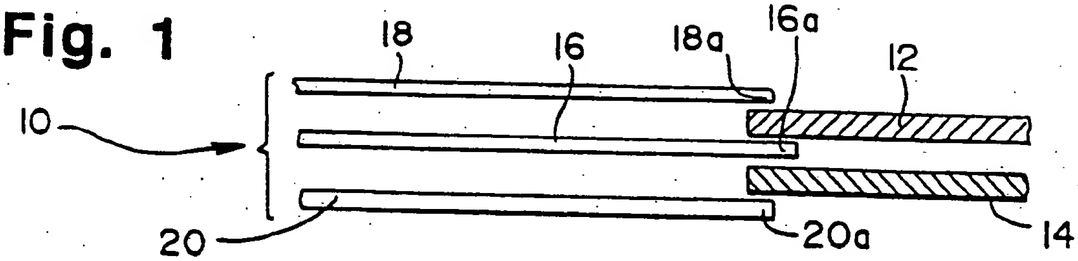

Fig. 2

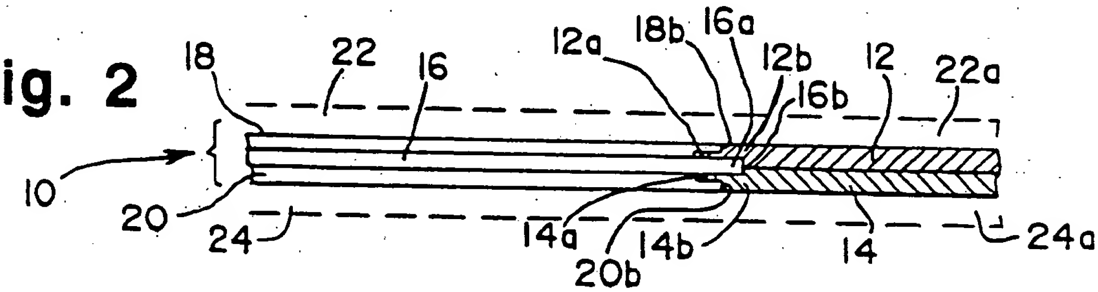

Fig. 3

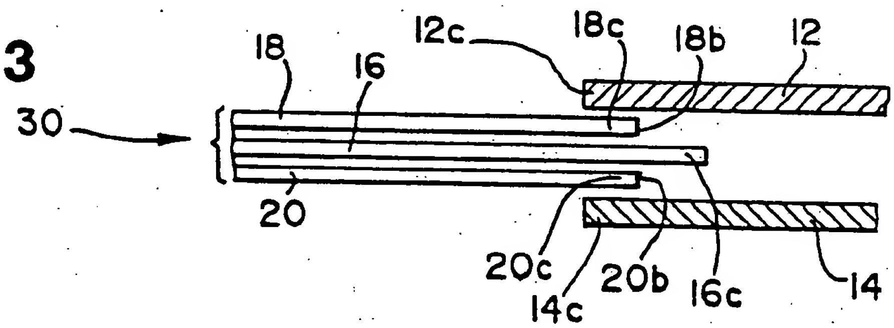

Fig. 4

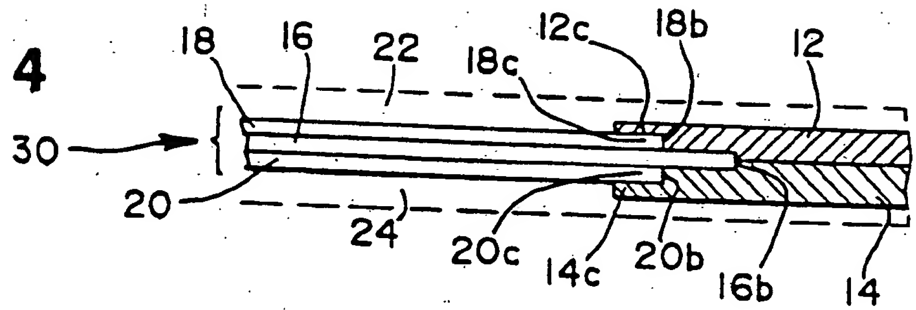

Fig. 5

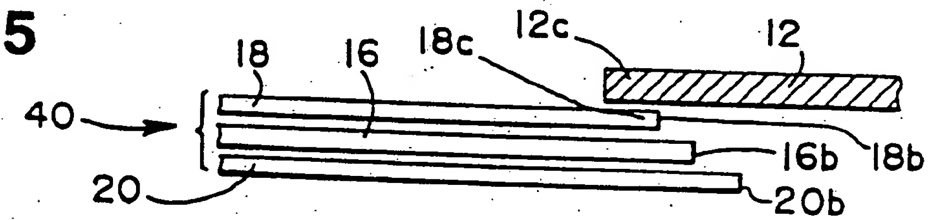

Fig. 6

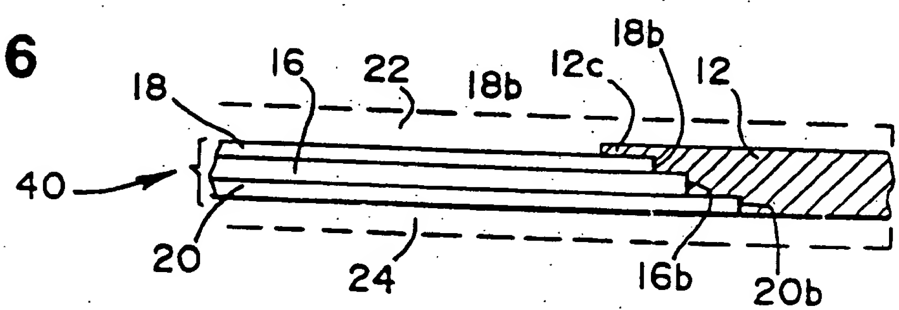

Fig. 7

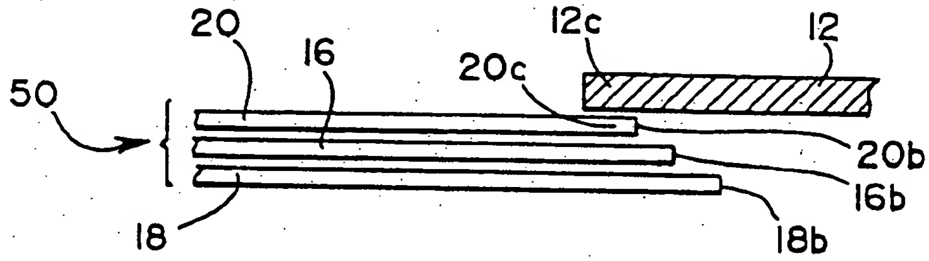

Fig. 8

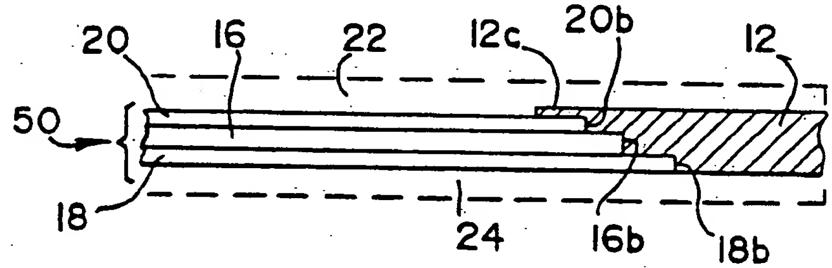

Fig. 9

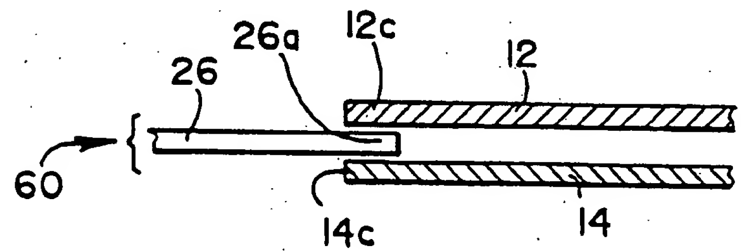

Fig. 10

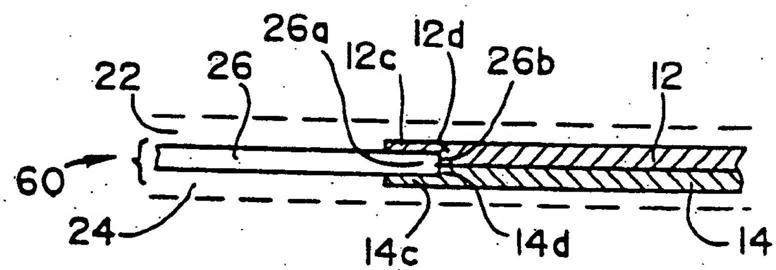

Fig.11

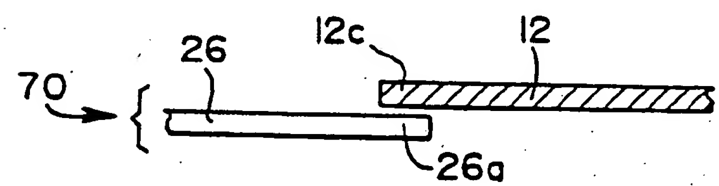

Fig.12